# National Institute of Environmental Health Sciences
**National Institutes of Health**

## SYMPOSIUM ON CHILDREN'S ENVIRONMENTAL HEALTH: IDENTIFYING AND PREVENTING ENVIRONMENTAL RISKS

**NIH Campus, Bethesda MD**
**February 24-26, 2003**

## OVERVIEW

When it comes to environmental exposures and health, children are uniquely vulnerable. Unlike adults, they are in an ever-changing state of growth, with rapidly multiplying cells and developing organ systems. In the womb, they are highly susceptible to exposures that can affect them for life. Even after birth, their nervous, respiratory, reproductive, and immune systems—still changing markedly--are especially sensitive to environmental exposures. Abnormalities induced in childhood can result in pre-dispositions to cancer and other diseases later in life. Young children breathe more rapidly and inhale more air relative to their body weight than adults do. Their metabolic rate is faster and their consumption of food and liquid are proportionately higher than that of adults. To illustrate, an infant doubles its weight in the first four months of life. Yet their kidneys excrete toxicants and wastes at a slower pace compared to adults.

Children also encounter unique exposure routes such as exposures across the placenta and through breast milk. Such common childhood behavior as putting hands and foreign objects into mouths also heightens exposure risks.

Fortunately, the field has moved well beyond mere recognition of children's unique vulnerability. It has advanced toward scientifically understanding why and how youngsters are more susceptible and toward developing and implementing practical ways to protect them.

The environmental research community is now in a scientific revolution regarding links between environment and health. Tremendous opportunities to protect health will result, according to experts who participated in the February 24-26 Symposium on Children's Environmental Health: Identifying and Preventing Environmental Risks.

Progress has been made across many fronts, especially in research. For example, cellular events in neurodevelopment no longer are complete mysteries for researchers. Both in vitro and in vivo studies reveal environmental agents can interfere with cell division, migration, differentiation, formation and pruning of synapses, myelinization, and apoptosis—processes all especially active and essential through childhood and into adolescence. Such information on key processes is critical for probing how exposures and changes in gene function impact development over various life stages.

Researchers are beginning to unravel the complex nature of gene environment interactions. Exploring geno-phenotype issues such as how gene expression can vary with age is one intriguing piece of the puzzle.

Researchers are exploring new techniques to probe such problems as defining individual susceptibility and exposure. For instance, the heightened use and development of increasingly sophisticated Geographic Information Systems (GIS) is helping investigators get a clearer picture of at-risk populations. Such technology makes it increasingly clear that income disparity is a contributing factor to environmental exposures. Researchers are also employing Global Positioning Systems (GPS) to track daily childhood exposures to pesticides and other pollutants and obtain better exposure data.

Yet much work remains not only to fill existing research gaps but to successfully use the research and put policy and prevention efforts in place. The constellation of talent engaged in environmental health

research is expanding as rapidly as the pace of the science. Some of the many disciplines needed include public health scientists, epidemiologists, toxicologists exposure assessors, clinicians, nurses, behaviorists and social scientists.

The symposium assembled leaders in environmental health research, policy, community outreach, and communications with an eye to help translate key environmental health information into public health policy and the practice of medicine. New approaches are needed in order for us to fully incorporate the new scientific findings to protect public health.

The core goals of the conference included: identifying the new research findings, profiling environmental threats to children, addressing ways to translate science into action to protect children, identifying research gaps (and initiating plans to fill them), and discussing ways to better communicate risk through strengthened media relations.

The symposium was divided into five key areas: respiratory disease and air quality, neurological impairments, childhood cancer, birth defects, and endocrine disruption. For each issue area, presenters and panelists discussed the current state of knowledge, its application, research gaps, health care perspective, implications of outreach policy, and communications and media relations. Other research areas such as violence and accidents are also important to children's environmental health but they were not emphasized in the program agenda.

This report is a summary of the symposium held at the Natcher Conference Center at the National Institutes of Health's (NIH)'s Bethesda campus in Maryland. The National Institute of Environmental Health Sciences (NIEHS) an institute of the NIH sponsored the conference and report.

For the conference framework, NIEHS employed its broad definition of the environment, which includes industrial and agricultural chemicals, such physical agents as heat and radiation, by-products of combustion and industrial processes, food and nutrients, prescription

drugs, lifestyle choices and substance abuse, social and economic factors and biological agents.

## NEW MODELS EMERGING FROM CONSENSUS

A general consensus was expressed across many broad themes at the conference. Foremost, prevention of exposure is the single most effective means of protection against environmental threats.

The timing of exposure or what stage in life it occurs remains the most critical factor in disease outcomes. Moreover, additional scientific evidence leads us to believe that fetal programming will turn out to be a vital part of the story. That is, exposures during a sensitive period of development in the womb may significantly influence later metabolic or physiological functions in adulthood.

Yet, new approaches and paradigms for thinking about the looming challenges continue to be needed. For a start, a more complex model of human disease must be developed that involves interaction between genetics and environment as a function of age, stage in development, and behavior. The model needs to be broadened to incorporate social, economic, and technological driving forces. Old paradigms that promulgated the notion that products should not be prohibited until they are proven harmful, need to be replaced with more contemporary models.

The Environmental Protection Agency (EPA) is currently evaluating a proposed approach for children's risk. It recognizes the research that shows differences in exposure, dose, and response between children and adults. Under this proposal, chemicals would be evaluated on a case-by-case basis on the weight of evidence. And science-influenced policy positions and procedures would be established as default to be used in the absence of data. EPA currently considers both effects manifested during childhood and early-life exposures that can contribute to later effects.

NIEHS advocates a three-pronged approach to children's environmental health. First, identify the risk factors be they genetic or environmental from laboratory, clinical, community, and population-

based studies. Second, develop ways to reduce exposure to those risk factors to prevent their expression, and finally, translate the knowledge and scientific information into public health policy and the practice of medicine.

Together NIEHS and the EPA have funded 12 children's environmental health research centers; the first opened in 1998. The centers represent key advances in research on children's environmental health issues. NIEHS has sponsored research on a host of threats to child health for more than 30 years including asthma, birth defects, learning and behavioral disorders, developmental disorders, cancer and low birth weight.

## INTERNATIONAL REACH

Although there have been extraordinary advances in the 20th century in protecting children's health, in 2000 some 10.9 million children under the age of five died worldwide. The figure is down from 12.7 million in 1990, according to the World Health Organization (WHO). Acute respiratory infections (ARI) account for the majority of deaths or about 2 million a year, diarrheal diseases account for 1.3 million, and malaria and other vector-borne diseases account for 1 million.

Worldwide the leading environmental risk factors include household water, hygiene and sanitation, air pollution, disease vectors, chemical hazards, and injuries and accidents.

WHO has been stepping up its activities with regard to children's environmental health, including conferences and workshops with support from NIEHS and EPA. WHO works to foster national movements by mobilizing political will at high levels, organizing national events, and developing concrete plans for possible studies and preventive campaigns.

Many panelists also encouraged participants to expand the push to improve children's environmental health globally. Developing countries in particular face more daunting threats, especially when compounds outlawed in the United States are still in widespread use

there and prevention, outreach, and policy lag further behind than in this country.

## CURRENT STATE OF KNOWLEDGE

### Respiratory Disease and Air Quality

Researchers have linked contaminants in the air to pregnancy loss, reduced birth weight, SIDS, ARI, respiratory symptoms, reduced lung function, asthma, cancer and neurocognitive function. Societal factors like poverty and access to medical care only compound such effects.

High levels of combustion-related pollution increase mortality and morbidity, including ARI. Previous exposures to high levels can be linked to later respiratory symptoms. Current exposure levels are associated with reduced lung function, some symptoms, and asthma severity. But changes in asthma frequency have not been explained solely by outdoor air pollution.

Susceptibility to inhaled pollutants is determined by age, genetic diseases like cystic fibrosis and asthma, and acquired lung disease. Where children spend time is also a critical issue for child respiratory health.

Viruses are an important component of disease, especially respiratory syncytial virus or RSV. Researchers have shown that viruses can not only cause asthma but make a child more vulnerable to get asthma.

Researchers speculate there may be a link between obesity and asthma, which both are epidemic in the U.S. This is an emerging area for new research studies.

Both prevalence and morbidity of asthma is higher in poor, urban minority communities. According to NHANES, 3 percent of whites and 7.2 percent of African American children age 6 months to 11 years are asthmatic. And the mortality rate among black children from asthma is more than double that of white children. Researchers cite emotional stress, lack of access to care and compliance, poor health

behaviors, and increased exposures as contributing factors to the higher morbidity and mortality in US inner cities. Moreover, risk of exposures from secondhand smoke, mold, cockroaches, dust mites and more are higher.

Indoor air pollutants include tobacco smoke, gas stoves and other combustion appliances, soil gas intrusion, furnishings and household products, building materials, biological agents, vehicles in garages, and outdoor sources. Smoke from biomass fuels increases risk for ARI. Second-hand smoke exacerbates asthma, increases risk for ARI, respiratory symptoms, and ear disease, and slows lung growth. Key outdoor pollutants include particles, ozone, biological agents, and hazardous air pollutants.

More actions are needed to address these issues. However, some progress has already been made in the policy arena in the area of air quality. Smoking bans are a leading accomplishment in protecting children's respiratory health. So are the posting of ozone action days. In Connecticut, anti-idling laws for school buses were enacted on the basis of exposure studies from mobile sites, resulting in the lowering of pollutants. More actions that combine science with policy activities are needed.

**Neurological Impairments**

While much of the early focus on deleterious effects of neurotoxins focused on decreases in IQ, which are significant, the cost to society is much broader in scope. Resulting neurodevelopmental disorders put children at risk of dropping out, teen parenting, drug abuse, crime, institutionalization, and suicide, studies reveal. Children's developmental disorders impact not only the afflicted kids but the lives of parents, teachers, school administrators, and communities.

While the effects of exposures to lead, mercury and PCBs are the best documented, the list of known and suspected developmental neurotoxicants also includes manganese, tobacco smoke and nicotine, and dioxins. Such pesticides as organophosphates, organochlorides like DDT, and pyrethroids, such solvents as ethanol, and food additives also make the list.

Nowhere is the story of children's exposure to neurotoxins more clear than the history of lead. In the past, industry blocked potentially embarrassing research from being conducted, discredited scientists whose work had troubling implications, and pressured regulators to ignore critics in favor of economic arguments.

While exposures to lead have decreased dramatically over the past four decades in this country much work remains. Still 8 percent of low income, 1.9 percent of middle income and 1 percent of high income children continue to be lead poisoned. African American and Mexican American children experience higher rates of lead poisoning than non-Hispanic white children.

Although the harm that lead causes to children rises as their blood lead levels increase, blood lead levels as low as one microgram per deciliter have been associated with harmful effects on children's learning and behavior.

A recent study identifies the continuing economic costs for lead poisoning to be $43.4 billion. The total economic costs to society for childhood diseases linked to environmental pollutants is estimated to be in the $54.9 billion range or 2.8 percent of total health care costs. Roughly $9.2 billion is for neuro-developmental disorders other than lead poisoning, $2 billion is for asthma, and $300 million is for childhood cancer.

Meanwhile exposures to known neurotoxicants like manganese and mercury continue unchecked. Manganese is present in high amounts in cow's milk and soy formulas while infants have literally no ability to excrete excess amounts. More than 10 percent of women of childbearing age have levels of mercury that exceeds EPA guidelines for reference doses. High doses of prenatal exposure can cause mental retardation, seizures, cerebral palsy, vision, hearing, and sensory disturbances.

## Childhood Cancer

Generally, researchers believe they know "far too little" about childhood cancers, which occur at a low rate population-wide.

Children under 15 years of age account for less than 2 percent of all U.S. cancers. About 8,500 are diagnosed each year with cancer with acute lymphoid leukemia being the most common, comprising 24 percent of all childhood cancers, followed by central nervous system cancers at 21 percent.

Since 1974, childhood cancers in the United States have been increasing at a rate of 1 percent per year, according to SEER data. Meanwhile, childhood cancer survivor rates have also been climbing. Internationally cancer rates have also increased. The reasons for the rise in rates remain unclear and controversy surrounds interpretations of the trend data.

There is no reliable source of childhood cancer cases or clusters because there is no national tracking and definitions have not been standardized. Cancer in itself is a complex disease. Cancers are really many diseases caused by different factors. The latency period for developing cancer is especially long compared to other diseases thus making the detection of or association between specific exposures and tumor development difficult. Risk varies by type, age, race, gender, exposure type, individual susceptibility and more.

Cancer clusters are difficult to study given that they are observations in search of a hypothesis. Only 10 to 15 percent of perceived cancer clusters are thought to be statistically significant. Thus, accurately communicating the scientific issues surrounding cancer clusters is challenging.

Exposure to ionizing radiation is a known environmental risk factor for acute lymphoblastic leukemia, acute myeloid leukemia, brain tumors, and osteosarcoma. Epstein-Barr virus has been linked to Hodgkin's disease and immune suppression therapy to non-Hodgkin's lymphoma. Chemotherapy has also been linked to acute myeloid leukemia and alkylating agents to osteosarcoma. Some researchers have linked childhood cancers to electromagnetic fields, in utero and postnatal infections, Vitamin K prophylaxis in newborns and more.

Diet (for example, cured meats, pesticides, tobacco, in utero exposure to alcohol) and parental occupations are also potential risk factors. No environmental risk factors are known for neuroblastoma,

retinoblastoma, Wilms' tumor, hepatoblastoma, Ewing's sarcoma, soft-tissue sarcoma and germ cell tumors.

Hereditary components of many childhood cancers are also known. For example, optic gliomas are 45 percent genetic and leukemia is thought to be up to 5 percent. Genetic markers of susceptibility are also well-known for some cancers. For example, Down's Syndrome increases the risk for all leukemias.

**Birth Defects**

Two to three percent of babies are born with a major birth defect. And roughly 18 percent of newborns are diagnosed with minor structural anomalies. Experts estimate functional deficits occur in 5 percent of children.

To this day, the role the environment plays in birth defects is still largely unknown. A recent report estimated the number to be anywhere from 3 to 25 percent, which makes informing the public more challenging.

Observant practitioners have identified thalidomide, rubella, dilantin, DES, alcohol, methyl mercury, and radiation as known inducers of birth defects. Chryptorchidism (failure of the testis to descend) is actually the most common birth defect. It occurs in four out of every 100 male babies.

The Centers for Disease Control and Prevention recently formed a Center on Birth Defects and Developmental Disabilities. The new center aims to prevent birth defects and developmental disabilities that modern medicine already knows how to prevent, pursue risk factors and causes for currently unpreventable birth defects and disabilities, promote wellness for individuals living with a disability, and build partnerships with similarly focused organizations.

A success story for birth defects prevention is the finding that folic acid or folate taken by women of childbearing age will decrease the risk of spina bifida. In 1998, breads and enriched cereal grain products were fortified with synthetic folic acid by order of the Food

and Drug Administration (FDA). All U.S. wheat, rice and corn are fortified at the rate of 140 micrograms per 100 grams of grain, thus providing most people with 100 micrograms of folic acid daily.

A national birth defects prevention study is under way. It is examining more than 25 defects, ranging from cleft lip to hypospadias to heart defects. So far, more than 8100 cases have been examined and tracked.

Birth Defect Research for Children, Inc. also has started a national birth defect registry to identify patterns of birth defects with the same or similar exposures. It collects data on maternal and paternal pre-conceptual and prenatal exposures. The database is designed to generate hypotheses.

The registry has initiated projects on bendectin, Agent Orange, gulf war contaminants, and several community based birth defects clusters. The latter include an oral cleft project in Dickson, Tennessee, and a lupus cluster study in Apopka, Florida.

**Endocrine Disruption**

Endocrine disruptors interfere with endocrine function through estrogenic, androgen or other hormonal pathways. These exogenous substances or mixtures can have adverse health effects in human and wildlife species and their progeny.

At what age exposure takes place is clearly the most critical factor when it comes to chemicals interfering with endocrine processes. Effects are dependant on species, age, gender, and dose.

Reported human health effects include declines in male reproductive health, endometriosis, hypospadias, shortened lactation, altered immune function, and developmental disabilities, among others. Potential classes of endocrine disruptors include effluents, flame retardants, fungicides, herbicides, insecticides, metals, pharmaceuticals, phenols, plasticizers, PAHs, soy products and surfactants. Specific examples of suspects include PCBs, chlorinated

pesticides like DDT (dicholorodiphenylthrichloroethane) dioxin, and some plasticizers, including phthalates.

Research into endocrine disruption is challenging due to a myriad of confounding factors. Distinguishing between direct and indirect effects and primary and secondary effects is often difficult because of homeostasis, programming, developmental sensitivity, and endocrine system cross talk. In addition, a given chemical may act through multiple mechanisms and many of the mechanisms are not well understood. Teasing out effects of natural and human-made chemicals can be difficult, too.

WHO advocates a weight of evidence approach even though data on a causative role for endocrine disruptors are generally lacking. The WHO International Programme on Chemical Safety wants to strengthen national capabilities to address chemical safety and establish a scientific basis for risk assessment and the safe use of chemicals.

Currently, NIEHS is collaborating with the CDC's National Center for Environmental Health on a project to analyze 70 potential endocrine disruptors in samples from the National Health and Nutrition Examination Survey (NHANES). Some naturally occurring phytoestrogens such as those found in soy products are also included. NIEHS also set up the Center for the Evaluation of Risks to Human Reproduction to assess how such compounds affect fertility and childhood development. So far it has reviewed roughly seven phthalate compounds.

EPA has assembled a panel of the National Toxicology Program to examine low dose effects of endocrine disruptors. This question has historically been highly contentious and begs further consideration.

A growing number of researchers and activists would like to see further study of such chemicals on thyroid function.

## SYSTEMIC GAPS

Gaps are pervasive throughout the environmental health network. Baseline data on exposures and diseases are lacking. There are gaps between research and prevention. Generally, there is a disconnect between clinicians, legislators, scientists, advocates, parents, and children. And the decision makers are often isolated from the community. Models of disease prevention from Public Health are needed.

### Research and Application

Although the knowledge base is expanding, there are significant research gaps across all five areas: respiratory disease and air quality, neurological impairments, childhood cancer, birth defects, and endocrine disruption. Data are wanting on everything from complex interactions of asthma endpoints to neurodevelopmental effects of current mercury exposures.

A lack of adequate exposure data greatly limits researchers' ability to determine clear-cut associations. Data are also lacking from developing countries, vulnerable populations, and on non-persistent organic pollutant (POP) chemicals. Long-term monitoring of wildlife has not been conducted to establish baseline data globally.

Unfortunately, current public health and disease tracking and monitoring also needs much improvement. For example, developmental disabilities are not tracked and most birth defects were not tracked until recent years. Such obstacles as privacy concerns often hamper collection efforts. Some defects are difficult to diagnose uniformly, such as undescended testes.

Vague endpoints, for instance, long latency periods between exposure and impairments further confuse researchers' abilities to establish cause and affect relationships. Because the biology is so complex, there is uncertainty in most models of disease. Genetic diversity of populations and disease phenotypes all factor in.

Exposure variables are wide-ranging. Types, timing, pattern, and duration of exposures all matter. In addition, limitations on many types of exposure assessment exist. For example, in terms of air quality the power of the data can depend on methods such as whether researchers used fixed or mobile sites. Often the analytical methods employed do not match the required sensitivity to answer our health risk questions. For many exposures, little long-term data are available and few data span the period from childhood to young adulthood.

Many animal studies may not be extrapolated easily to children and our animal test systems need to be evaluated to ensure that all windows of vulnerability are adequately assessed from implantation to adolescence.

All these obstacles to research and application hinder development of effective prevention strategies that are well received by communities.

## Outreach Policy and Communicating Risk

Barriers to community outreach are far-flung. For a start, difficulties translating complex information into easily understandable language hampers communication.

Winning the trust of communities can be challenging. Commonly, there are many misconceptions about children's environmental health at large. For example, a community may not understand that behavioral problems might be tied to an exposure. The feeling that there is no control over chemical exposures and the fact that genetic factors make disease outcomes predetermined, also hinder outreach.

Working with communities can also be frustrating for many due to assorted political and social reasons. Sometimes a viable policy solution simply is too elusive. For example, exposures to benzene from gasoline fueling stations in Alaskan communities may be impossible to mitigate if the political will does not exist to change state law.

However, the symposium talks and presentations also emphasized the rewards from working in partnerships with communities. Using two-way communication dialogues, unidentified problems as well as solutions have been identified in many communities addressing many important environmental health concerns.

Health care providers face many obstacles to outreach within the practice of medicine. Currently, most health care providers don't know much about environmentally induced diseases in part because it's not part of core curricula. Instead, they focus on treating the disease. In addition, doctors and nurses are under increasing time restraints in seeing and treating patients and have little time to incorporate new tasks into their routine. What's more, they often lack clear information on the status of environmental hazards. A lack of biomarkers and clear diagnostic criteria further obfuscate the matter.

Researchers and policy advocates are often frustrated with bad experiences with the media. The story that is often published is not the story they feel they told the reporter. Tight time and space constraints and other pressures that journalists face often mean good science is lost in translation or key information ends up on the cutting room floor or edited out to make way for a giant headline or glossy picture.

## RECOMMENDATIONS

### Strengthen the public health system, including federal, state, and local components

- Increase environmental health officers in public health service, state bureaus, and local departments

### Substantially increase scope and depth of federal research into environmental threats posed to children and resulting disease outcomes.

- Push for comprehensive, longitudinal, prospective cohort studies from conception through adulthood for five key areas.

- Establish better definitions of sensitive biomarkers for susceptibility in humans and experimental systems.

- Develop a better understanding of children's environmental exposures that are different from those in adults.

- Pinpoint development periods when exposure to certain substances can cause adverse health effects.

- Achieve better exposure assessment and personal characterizations, whether they are temporal, spatial or based on physical activity. Achieve better assessment of how both environmental and genetic factors can impact metabolic and other physiological/biochemical pathways.

- Develop a better understanding of endpoint interactions of such complex diseases as asthma, acute respiratory disease, chronic respiratory disease.

**More aggressively apply a broad foundation of research by public health, medicine, and other sectors at the national, state, and local levels.**

- Conduct a better analysis of individual human data in currently available databases. For example, apply NHANES data more widely.

- Work to better decipher variation in exposure and susceptibility, effects due to mixtures, interactions with other exposures, pre-existing diseases and conditions, and uncertainties in estimating risks.

- Improve coordination of monitoring data and health surveillance data; nationally, regionally, and internationally.

- Strengthen emerging tracking efforts for birth defects, cancers, neurological disorders, asthma and other childhood diseases.

- Challenge existing perceptions about what is dangerous. Even in the face of uncertainty, in many situations enough data have accumulated to implement safer and better practices.

- Help make science a tool of the taxpayer.

**Revitalize a collaboration of public health, medicine, and the community.**

- Promote better use of NIEHS Environmental Health Centers by communities.

- Promote more NIEHS-sponsored town meetings to bring more local groups together and create coalitions around a specific public health concern.

- Make the issue relevant to middle class people (potent agents for change) of identifying and protecting against environmental threats to children.

- Foster collaborations between key federal environmental health agencies but also less obvious players such as the Department of Housing and Urban Development (HUD), Department of Transportation (DOT), Department of Agriculture, Department of Interior, and Department of Education

- Include the built environment in models of children's environmental health.

**Bolster the health care perspective.**

- Target all health care providers--doctors, nurses, and other practitioners from acupuncturists to mid-wives.

- Increase health the care providers' understanding of changes in vulnerability at various life stages.

- Work to change health care providers' attitudes so children's environment health interests are prominent. More than

providing information is required, a paradigm shift is needed. Efforts to incorporate environmental health into curriculum from kindergarten through medical school may help.

- Incorporate more environmental health into the curriculum across various health care professions. Getting questions about environmentally-induced diseases onto the appropriate examinations and boards will help.

- Encourage professional associations to educate their members. For example, the American Academy of Pediatrics' green book is one such tool.

- Develop more tools to help health care providers balance the health risks, for example, of controlling pests through insecticide use vs. alternative cockroach infestation control.

- Expand use of GIS in the field to help demonstrate visually the unequal distribution of diseases, exposures and other risk factors.

- Institutions such as hospitals and schools need to think more globally about lifecycle with how they use environmentally sensitive products. Many examples exist on how to "green the cleaning" and such models can be useful and economically and environmentally friendly.

- Advocate that clinicians speak out through professional organizations' position statements. For example, the American Academy of Pediatrics has effectively done so.

**Improve and expand prevention policies and outreach strategies.**

- Continue to build on past successes. Lead's removal from gasoline, pipes, new paint, and other sources has dramatically reduced childhood blood lead levels nationally. But lead exposure remains a major problem, according to recent papers on the subject. Too many children are still being exposed from

old housing and old paint, and physicians are treating them after the fact. Studies reveal irreversible damage is done even when lead is removed from the blood through chelation therapy.

- Expand successful tools and programs. For example, the ”healthy homes” initiative to reduce lead exposure was effectively broadened to include many issues, including asthma interventions, water/ mold contamination, and radon. If a home qualifies for HUD, public health intervention can be incorporated in a broad sense. (HUD has a large cross-disciplinary stakeholder base that includes public health nurses, housing contractors, inspectors and more.)

- Incorporate gatekeepers, for example, scientists, and housing officials into action plans.

- Encourage schools to play a bigger role in educating students about best practices. For instance, “green” schools create safer environments and help prevention efforts.

- Expand the focus of Head Start programs.

- Extend folate fortification efforts nationally and internationally. Since campaigns to fortify foods with folate in this country were introduced, birth defects linked to its deficiency have sharply dropped. In this way, Spina Bifida might be eradicated much like polio.

- Replicate government programs that work in other cities and communities. For example, government controls on car traffic have improved air quality in such cities as Paris, where odd and even days for driving were implemented and London where congestion zones were demarcated. Community efforts to stop idling of buses at bus stops has also proven to be a success story for reducing air pollution.

- Devise ways to combat advertising that promotes use of products like pesticides or toxicants that aren’t really necessary or are used excessively.

**Foster better communications and media relations.**

- Develop more clever ways to make environmental health information relevant and accessible to the general population. For example, the American Lung Association's State of the Air reports have been highly successful. The annual look at ozone pollution grades cities from A to F based on their air quality. In 2002, the report reached more than 1,100 media outlets and generated 12.5 million website hits in the first two weeks after posting.

- Improve risk communication, in particular, through the media.

- Educate environmental health researchers on better strategies for dealing with media.

- Encourage researchers and policymakers to help the media when they can, even spoon-feed them story ideas when possible.

- Promote researchers, environmental organizations and the like to be patient with reporters. Often reporters have to ask clarifying questions to effectively translate complex messages into messages understood by the general public.

- Assist reporters in putting a human face on information and make it interesting and relevant to the typical citizen.

- Encourage researchers to be clear and honest with reporters about what they know and what they don't. The credibility of the field, as well as that of the news organization, is on the line.

- Support development of long-term relationships between advocates and researchers and media outlets.

## CONCLUSIONS:

The children's environmental health community needs to sustain its momentum and continue to build on its successes and lessons from the past and to fully explore areas of future promise.

Reinvigorating the public health system at all levels will be just a start. The environmental health community needs to push to fill the research gaps outlined in this report across key areas of concern: respiratory disease and air quality, neurological impairments, childhood cancer, birth defects, and endocrine disruption.

Application of environmental health knowledge needs to be improved at all levels, including within the health care community. Such efforts will work to strengthen prevention policies and strategies. Revitalizing cooperative efforts and dialogue between public health, medicine, and communities will go a long way toward improving community outreach and risk communication as well.

How society defines the realm of children's environmental health requires continued expansion to achieve an all-encompassing perspective. Besides pediatricians, basic researchers, toxicologists, and epidemiologists, the field belongs to urban planners, transportation engineers, landscape architects, developers, lenders, community activists, citizen stakeholders and more. All of whom can contribute to preventing unnecessary exposures and improving children's environmental health.

All these themes fold into a key point underscored by NIEHS Director Kenneth Olden at the conference:  the environmental health community and society at large must remember that children are not bland statistics but real people who deserve the best society can offer.

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